

Amendments to the Drawings:

The attached sheet of drawings includes changes to Figure 3. This sheet, which includes Figure 3, replaces the original sheet including Figure 3. In Figure 3, the following changes have been made:

The label on block 330 has been changed from "IN-PHASE ANALOG TO DIGITAL CONVERTER (ADC)" to "IN-PHASE DIGITAL TO ANALOG CONVERTER (DAC)".

The label on block 360 has been changed from "QUADRATURE ANALOG TO DIGITAL CONVERTER (ADC)" to "QUADRATURE DIGITAL TO ANALOG CONVERTER (DAC)".

The label on block 320 has been changed from "BANK OF SUB-CARRIER DEMODULATORS" to "BANK OF SUB-CARRIER MODULATORS".

Attachment: Replacement Sheet

REMARKS/ARGUMENTS

In response to the outstanding Office Action, certain corrections have been made to Figure 3. These corrections are fully in accordance with the original disclosure, and therefore are not new matter.

In the outstanding Office Action, claims 47-71 were allowed, claims 1, 3-7, 9-12, 15, 24, 26-30, 32-35 and 38 were rejected under 35 U.S.C. 103(a), and claims 2,8,13-14,16-23,25,31,36-37 and 39-46 were objected to.

In response to the outstanding Office Action, most of claims 1-46 have been amended to better define the invention. Major base claims are amended significantly and their scope has been further specified. With respect to the Examiner's objection to claims 2,8,13-14,16-23,25,31,36-37 and 39-46, these claims have been carefully amended in accordance with the Examiner's comments, either by limiting the scope of their base claims or/and amending the dependent claims themselves.

In the outstanding Office Action, claims 1, 3-7, 9-12, 15, 24, 26-30, 32-35 and 38 were rejected under 35 U.S.C. 103(a) as being unpatentable over Isaksson U.S. Patent 5,726,973.

The original description of claims 1 and 7 of the present invention shares some similarities with Isaksson's block diagrams in formality, although they differ in many aspects. For example, the apparatus of the present invention will generate two output complex numbers that have equivalently the same frequencies to the two input signals, respectively, preserving the symmetric property around the center frequency of a multi-carrier signal, while in Isaksson, the two output signals (the timing error signal F1 and the phase error signal F2) are not. In Isaksson, F1 will be used to adjust the sampling timing for the data symbols modulating all sub-carriers of the multi-carrier signal while F2 will be used to adjust the center frequency of the multi-carrier signal.

Moreover, the present invention needs pre-calculated balancing parameters beforehand. The parameters may vary from unit to unit. But once a unit is physically built, the balancing

parameters are determined by carrying out a training process, and, during any receiving or transmission session later on, the parameters are fixed.

To further distinguish from others, claim 1 and claim 7 have been amended to emphasize that the apparatus includes a deterministic procedure calculating the balancing parameters in a training process before they are used to generate balancing signals. And subsequent claims are also amended accordingly to better describe the present invention.

Claims 15-23 are further dealing with the I-Q balancing apparatus used for a transmitter with I-Q imbalance impairment. Now, the resulted “balanced signals” as the output signals of the apparatus are actually pre-distorted signals that are fed to two of the sub-carrier modulators so that the final multi-carrier signal after the up-conversion by the transmitter’s I-Q mixers has no adverse effect on I-Q imbalance. These claims are amended to reflect the situation more accurately.

Claims 24-37 are dealing with an I-Q balancing method used for a receiver having I-Q imbalance impairment. Claims 38-46 are dealing with the I-Q balancing method used for a transmitter with I-Q imbalance impairment. Many of them are amended significantly for the reasons similar to those of claims 1-23.

Claim 47 had some typos, in that the number of sub-carriers (signals) should be $2P$ for the situation when P basic (balancing) blocks are used and that two “subtractor” and a “subtract” should be “combiner” and “combine” respectively, and has been so amended to correct the errors.

Claim 61 is amended substantially so that it becomes a claim independent of claim 47 because claims 61-69 define a system with a transmitter impaired by I-Q imbalance. Relevant claims are also amended accordingly to more accurately describe this part of the present invention.

As for the other cited references of Andre, Wiss, and Alelyunas, their approaches assume that the I-Q imbalance is frequency independent – i.e., the gain difference of the I and Q channels are the same over a frequency band of interest, and phase offset (from 90 degrees) is a

constant across the frequency band. But in many cases the I-Q imbalance is frequency dependent. For example, the I-channel filter and Q-channel filter may have different corner frequencies and/or in-band gain ripples, and thus the related I-Q imbalance may be frequency dependent.

Moreover, these approaches cannot deal with large phase offset and amplitude (gain) imbalance at the same time, since amplitude imbalance may cause estimation errors in determining phase offset, and vice versa. If using a trial and error method or assuming one of imbalance is too small to affect the other, then there may be an underlying convergence issue.

By contrast, the present invention can precisely remove the effect of frequency dependent I-Q imbalance and handle any imbalance combining large I-Q phase offset and I-Q amplitude discrepancy. The balancing parameters are deterministic parameters pre-calculated in a training process. And any training signals (sine waves) – independent of their amplitude and phase – generate the same balancing parameters, because the calculation of parameters is based on (complex) ratios of some complex numbers.

For the foregoing reasons, the application is now believed to be in condition for allowance, and accordingly, allowance at an early date is respectfully requested.

CONCLUSION

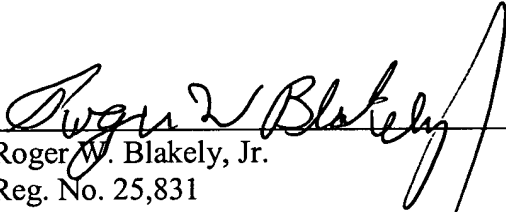
Applicant respectfully requests that a timely Notice of Allowance be issued in this case.

Respectfully submitted,

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Dated: 07/07/2006

By


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